

Appl. No. 09/388,265
Amdt. dated October 22, 2003
Reply to Office Action of May 22, 2003

PATENT

REMARKS/ARGUMENTS

Claims 8-27 are pending.

Claims 8-24 and 26 stand rejected under 35 U.S.C. 102(e) as being anticipated by Miki (PN 6,268,618).

Claims 25 and 27 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Miki (PN 6,268,618).

These rejections are respectfully traversed and reconsideration is respectfully requested.

Applicant has amended independent claims 8 and 16 to more clearly identify a novel aspect of the present invention. Specifically, claim 8 has been amended to recite that the ohmic contact comprises a layer of p-type semiconductor oxide and metal in a condition of mixed morphology, wherein both the p-type semiconductor oxide and the metal connect the p-type semiconductor material. This amendment is supported by at least Figure 1. In addition, claim 16 has been amended to recite that the ohmic contact comprises a layer of p-type semiconductor oxide and a conductive layer, wherein the layer of p-type semiconductor oxide is located on the p-type semiconductor material, and the conductive layer is located on the layer of p-type semiconductor oxide. This amendment is supported by at least Figure 2.

The Present Invention

Figure 1 and page 4, lines 20-23 of the present application describe a first embodiment of the present invention. A film including a transition metal and a noble metal is deposited on a p-type GaN substrate (10). By performing heat treatment in an oxidizing environment, the transition metal is oxidized to form a p-type semiconductor oxide (12), wherein the film is a composite structure of the p-type semiconductor oxide (12) and the noble metal (14). It should be noted that, according to Fig. 1, both the p-type semiconductor oxide (12) and the noble metal (14) connect the p-type GaN substrate (10). Thus, a much lower interface resistivity of $1.0 \times 10^{-4} \Omega\text{-cm}^2$ can be obtained.

Figure 2 and page 9, line 23 to page 10, line 5 of the present application, describe a second embodiment of the present invention. Since the interface impedance of the p-type semiconductor oxide and p-type GaN is very low, and the noble metal can form an ohmic contact having a low resistivity with the p-type semiconductor oxide, the second embodiment teaches a layer of p-type semiconductor oxide (12) and a layer of noble metal (14) sequentially formed on a p-type GaN substrate (10). It should be noted that, according to Fig. 2, the p-type semiconductor oxide (12) is located between the noble metal (14) and the p-type GaN substrate (10), different from the sequence of the layers of the cited reference (PN 6,268,618). Thus, a much lower interface resistivity of $1.0 \times 10^{-4} \Omega\text{-cm}^2$ can be obtained.

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35 U.S.C. 102

In the Office Action, claims 8-24 and 26 are rejected under 35 U.S.C. 102(e) as being anticipated by Miki (U.S. patent No. 6,268,618).

Miki teaches a light-permeable electrode (11) consisting of a first layer (11a) of a light permeable metal formed on the surface of the p-type GaN layer (30), and a second layer (11b) consisting of a light-permeable metal oxide formed on the first layer (11a). Also, Miki uses X-ray diffraction (XRD) to find the first layer (11a/111a) is comprised of metal (Au), and the second layer (11b/111b) is comprised of NiO and a small amount of Ni. Due to the second layer (11b/111b) formed on the first layer (11a/111a), the NiO (referred to as semiconductor oxide) in the second layer (11b/111b) does not connect the p-type GaN substrate (30). See Figs. 1, 6-12 and 15-22 and Col. 4, lines 31-46, Col. 8, line 60 to Col. 9 line 9, Col. 9 line 61 to Col. 10, line 3, Col. 10, lines 59-65, Col. 16, lines 33-55, Col. 18, lines 28-44, Col. 19, lines 48-55, Col. 21, lines 21-31, Col. 22, lines 55 to Col. 23, line 13, Col. 28 lines 3-10 and Col. 29 lines 28-35.

However, it is respectfully submitted that Miki does not anticipate claim 8 because it does not teach or suggest the ohmic contact comprising a layer of p-type semiconductor oxide and metal in a condition of mixed morphology, wherein both the p-type semiconductor oxide and the metal connect the p-type semiconductor material. In addition, Miki does not anticipate claim 16 because it does not teach or suggest the ohmic contact comprising a layer of p-type semiconductor oxide and a conductive layer, wherein the layer of p-type semiconductor oxide is located on the p-type semiconductor material, and the conductive layer is located on the layer of p-type semiconductor oxide.

Applicants respectfully emphasize that the function of the oxide layer of the present invention is different from that of the cited reference. The oxide of the present invention is semiconductor oxide, which helps carriers to penetrate the interface between the ohmic contact and the p-GaN substrate. Thus, a low specific contact resistance can be obtained. In contrast, referring to Col. 9, line 61 to Col. 10, line 3 and Col. 17, lines 13-14 of Miki, the function of the metal oxide (11b) of the cited reference is to prevent the ball-up phenomenon from occurring in the first layer (11a) of metal, so as to increase adhesion therebetween. That is, referring to Col. 9, lines 11-21 of PN 6,268,618, the metal oxide (11b) of the cited reference could be semiconductor oxide (e.g. NiO, SnO, Cr₂O₃, CoO, ZnO, CuO₂, In₂O₃) or insulator (MgO). The metal oxide (11b) at the overlap/laminated portion of the bonding electrode is then removed (shown in Figs. 9, 10, 12, 15, 18, 20 and 22). As a result, both the structure and the oxide function according to the present invention and the cited reference are different.

Thus, the cited reference does not describe or suggest all the elements of the present invention as set forth in independent claims 8 and 16 of the present invention, and, as much, cannot anticipate these claims under 35 U.S.C. 102.

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35 USC 103

As noted previously, Miki does not anticipate amended claim 16 because it does not teach or suggest the ohmic contact comprising a layer of p-type semiconductor oxide and a conductive layer, wherein the layer of p-type semiconductor oxide is located on the p-type semiconductor material, and the conductive layer is located on the layer of p-type semiconductor oxide. In electrode (11) of the prior art, the first layer (11a) of metal is located between the second layer (11b) of a light-permeable metal oxide and the p-type GaN substrate (30). That is, the second layer (11b) of a light-permeable metal oxide does not connect the p-type GaN substrate (30). Contrarily, according to the present invention, the p-type semiconductor oxide layer (12) connects the p-type GaN substrate (10). That is, the sequence of the layers with the present invention is opposite to the cited reference, and therefore, Miki cannot make the present invention obvious under 35 U.S.C. 103.

Thus, the prior art cannot make the present invention obvious under 35 U.S.C 103, as there is no suggestion of the ohmic contact comprising a layer of p-type semiconductor oxide and a conductive layer, wherein the both the p-type semiconductor oxide and the metal connect the p-type semiconductor material. In addition, the prior art cannot make the present invention obvious under 35 U.S.C 103, as there is no suggestion of the ohmic contact comprising a layer of p-type semiconductor oxide and a conductive layer, wherein the layer of p-type semiconductor oxide is located on the p-type semiconductor material, and the conductive layer is located on the layer of p-type semiconductor oxide.

For the reasons mentioned above, Miki does not teach that both the p-type semiconductor oxide and the metal connect the p-type semiconductor material, and the layer of p-type semiconductor oxide is located between the p-type semiconductor material and the conductive layer. It is therefore applicants' belief that claims 8 and 16 are allowable over the cited art. Insofar as all claims depend from claims 8 and 16, it is applicants' belief these claims are also allowable for at least the reasons claims 8 and 16 is allowable.

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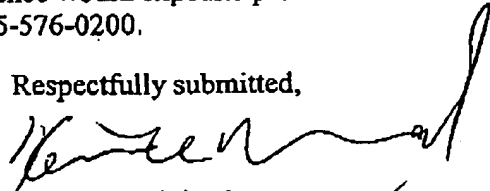
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CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,


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